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ABSTRACT

This document reviews the Japanese educational system and examines middle school education in particular to identify cultural differences and help improve educational quality in the United States. Contents include: (1) "An Overview of Japanese Education"; (2) "Teacher Behavior in the Classroom"; (3) "Teacher Behavior Outside the Classroom"; (4) "Equality and Equity"; and (5) "Conclusion". (YDS)

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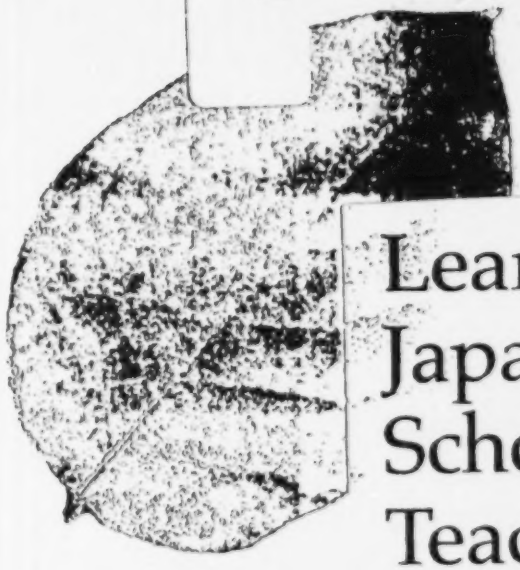

Learning from Japanese Middle School Math Teachers

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Nancy C. Whitman

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Nancy C. Whitman

Nancy C. Whitman is a professor of mathematics education at the University of Hawaii at Manoa. Her publications on Japanese mathematics education include "Teaching of Mathematics in Japanese Schools" in *Windows on Japanese Education*, edited by Edward Beauchamp and published by Greenwood Press (1991); "Mathematics Education: A Cross-Cultural Study" in the *Peabody Journal of Education* (1997); and *A Case Study of Japanese Middle Schools, 1983-1998*, published by University Press of America (2000).

In 1983 and 1992 Whitman spent her sabbatical leaves in Japan, obtaining data for her Japanese studies. In 1998 she conducted follow-up studies to her previous work in Tokyo. She continues to visit Kitamachi Middle School, a key site of her first study.

Several former graduate students who are Japanese nationals were, and continue to be, helpful in providing information regarding Japanese education. Whitman gratefully acknowledges these individuals, in particular Masami Masahiro, Tadayuki Ishida, and Hiro Uchida.

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by
Nancy C. Whitman

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Introduction

The focus of this fastback is to explore ideas to improve middle school mathematics education by examining what others have done in another culture. In particular, I look at what has been done by the Japanese, who have been very successful in international comparisons of mathematics achievement (TIMSS 1996; Westbury and Travers 1990; Husén 1967). Before looking at particular ideas and methods used by Japanese middle school educators, it is useful to present an overview of Japanese education and middle school mathematics education, in particular. This is helpful because mathematics education in Japan must be viewed in the context of Japanese schooling. It is followed by looking at the behavior of middle school mathematics teachers in the classroom and outside of the classroom and then at the relationships of the mathematics teacher to administrative and other related matters.

Information in this fastback is based primarily on my fieldwork in Japan over a period of 16 years, 1983-1998 (Whitman 2000; Whitman 1991; Whitman et al. 1997; Whitman et al. 1986). It included numerous classroom

observations and interviews with teachers, administrators, and researchers. It also included the videotaping and analysis of teaching. The fieldwork took place primarily in 1983, 1992, and 1998. The main sites for visitations were Tokyo, Kyoto, Osaka, and Sapporo. I consulted numerous education documents concerned with Japanese education, including national documents published by the Japanese Ministry of Education and publications by the prefectures (provinces), cities, and individual schools. In addition to classroom observations, analysis of videotapes, interviews, and the study of official documents, I also collected and analyzed student achievement data.

An Overview of Japanese Education

To get an understanding of mathematics education in Japan, it is helpful to understand Japanese education in a general sense. In Japan, the types of schools for each educational level are as follows:

Pre-primary education consists of kindergarten for students 3-5 years old.

Primary education consists of elementary schools for students 6-11 years old.

Secondary education consists of lower secondary schools for students 12-14 years old, secondary education for students 12-17 years old and older, upper secondary schools for students 15-17 years old, College of Technology for students 15-19 years old, and Specialized Training College for students 15 years old. Lower secondary schools for students 12-14 years old are commonly referred to as middle schools in the United States. They also may be referred to as junior high schools.

Tertiary education consists of Junior College for students 18-19 or 20 years old and University for students 18-21 years old or older.

The main academic track is from the upper secondary schools to the university. Primary education and lower secondary education are compulsory. Public compulsory education is coeducational. At the present time, participation rates in primary, lower secondary, and upper secondary education are almost 100%; about 50% of each age cohort is enrolled in tertiary education.

There exist in Japan national standards for education in kindergarten, elementary schools, lower secondary schools, upper secondary schools, and special education schools. These are presented in *Courses of Study*, published by the Ministry of Education, Science, Sports, and Culture. In the *Courses of Study*, objectives and contents are stated for each subject.

Each middle school has approximately 800 students, regardless of its location. The school buildings are generally alike. There is nothing special about their appearance. What is very special about middle-level education is that the students are guided into taking the most appropriate high school entrance examination. This is critical because high school education is not mandatory, and yet nearly all students enter high school. In addition, students may take the examination only once a year. If students do not succeed in getting into the high school of their choice, they must wait a whole year for another opportunity. The high school attended is extremely important in Japan, for it determines students' postsecondary education, which in turn affects their job placement.

In 1998 revisions to the *Courses of Study* were made for the kindergarten, primary, and lower secondary

schools. Implementation of these revisions, slated for 2001 and 2002, is completed. For the upper secondary schools, revisions were made in 1999 and implementation will occur in 2003.

In addition to objectives and contents being prescribed for each subject, time allocation and number of credits for each subject are given in the *Regulation for Enforcement of School Education Law* and in the *Courses of Study*.

The prescribed regular subjects and their minimum school "hours" (1 hour = 50 minutes) per school year in grades 7, 8, and 9 are shown in Table 1.

Table 1. Class Hours per Subject

Subject	grade 7	grade 8	grade 9
Japanese Language	140	105	105
Social Studies	105	105	85
Mathematics	105	105	105
Science	105	105	80
Music	45	35	35
Fine Arts	45	35	35
Health and Physical Ed.	90	90	90
Industrial Arts or Homemaking	70	70	35
Foreign Language	105	105	105
Moral Education	35	35	35
Special Activities	35	35	35
Elective Subjects	0-30	50-85	105-165
Period for Integrated Study	70-100	70-105	70-130

For each of the required subjects, moral education, and special activities, *Courses of Study* provides a set of objectives, content, suggestions for the preparation of

the teaching program, and points for special consideration in teaching.

Courses of Study for lower secondary (middle) school provides the framework for curricula that each school organizes, taking into account the actual conditions of its local community and school and the development and characteristics of its people.

Use of Time. Japanese students go to school year round. The school year begins on April 1 and ends on March 31 of the following year. It is made up of three terms, each of which is followed by a vacation period.

The first term begins about the first week in April and ends about the third week of July, followed by approximately 40 days of summer vacation (about July 21 until August 31). The second term begins early in September and ends about December 25, followed by 13 days of winter vacation (about December 26 until January 7). The last term begins about the second week in January and ends around the third week of March, followed by 10 days of spring vacation (about March 2 until April 5).

In addition to summer, winter, and spring vacations, the schools also celebrate 14 holidays: New Year's Day (January 1); Adults' Day (the second Monday of January); National Founding Day (February 11); Vernal Equinox Day (about March 21); Greenery Day (April 29); Constitution Memorial Day (May 3); Children's Day (May 5); Marine Day (July 20); Respect for the Aged Day (September 15); Autumnal Equinox Day (about September 23); Health-Sports Day (the second Monday

of October); Culture Day (November 3); Labor Thanksgiving Day (November 23); and the Emperor's Birthday (December 23). Private schools decide their school holidays.

Beginning in April 2002, a comprehensive five-day school week was implemented. This discontinued Saturday morning classes, previously required.

School Day. While the Ministry of Education does not provide guidelines for how the school day should be used, it does prescribe a minimum standard of instructional times for each course of study. For example, as previously noted, 105 class hours (50-minute periods) of mathematics are required for each of grades seven, eight, and nine. Consequently, a typical school day that begins at 8:30 and ends at 3:50 might be scheduled as show in Table 2.

Table 2. Typical Middle School Schedule

8:30-8:40	Morning meeting
8:45-8:55	Homeroom
9:00-9:50	Period 1 Formal instruction
10:00-10:50	Period 2 Formal instruction
11:00-11:50	Period 3 Formal instruction
12:00-12:50	Period 4 Formal instruction
12:50-1:20	Lunch
1:20-1:40	Recess
1:40-2:30	Period 5 Formal instruction
2:30- 2:40	Homeroom
2:40-3:00	Cleanup
3:00-3:50	Clubs, student meetings, and activities

The 50-minute class periods are devoted wholly to instruction. Absent are the reading of announcements by the teacher or student, the interruption of the class period by announcements over the public announcement system, and the doing of homework in class.

There are 10-minute breaks between classes. These breaks provide an intense recess time for the students, who take this time to release a lot of energy and tension and to clear their minds before they take on the next subject. Student behavior during these breaks contrasts vividly with their behavior during class time. Both private and public schools provide frequent recesses, and there is very little difference in student behavior between public and private schools.

The ministry also prescribes the course objectives and content and offers suggestions for teaching. Following is an abbreviated overview of the mathematics requirements.

Grade Seven

Numbers and Algebraic Expressions:

- To be able to perform the four basic fundamental operations and to recognize positive and negative numbers through activities in concrete situations.
- To develop the ability to express relationships and rules in algebraic expressions using letters. To grasp the meaning of expressions and be able to calculate algebraic expressions using letters.
- To know and apply linear equations with one variable.

Geometrical Figure:

- To enhance the ability to fully understand basic plane figures and to construct these figures.
- To understand further the concept of solid figures through observation, manipulation, and experimentation and to increase students' ability to measure figures.

Mathematical Relations:

- To increase the capability to discover, express, and relate proportional and inversely proportional relationships by investigating the changes and correspondence of two quantities in concrete phenomena.

Grade Eight

Numbers and Algebraic Expressions:

- To determine quantitative relationships about phenomena, to build up students' ability to use these and express them using letters in algebraic expressions, and to be able to apply the four basic operations using algebraic expressions.
- To understand simultaneous linear equations with two variables and their solutions.

Geometrical Figures:

- To find the properties of basic plane figures through observation, manipulation, and experimentation. To verify these properties based on the nature of parallel lines.
- To find the properties of plane figures based on the conditions for congruence of triangles and so forth.
- To cultivate powers of logical reasoning.

Mathematical Relations:

- To extract two quantities from concrete phenomena and investigate their changes and correspondence.
- To understand linear functions, and cultivate the student's ability to learn how to find, consider, and express relationships in terms of functions.
- To understand the concept of probability through observation and experimentation involving concrete phenomena.

Grade Nine

Numbers and Algebraic Expressions:

- To learn and apply the use of square roots of positive numbers.
- To be able to expand and to factor simple polynomial expressions, especially using letters, and to be able to transform algebraic expressions according to their purposes.
- To learn and apply quadratic equations.

Geometric Figures:

- To verify the properties of figures based on the conditions for triangle similarity and to develop the ability to consider and express logically.
- To understand fully the Pythagorean theorem.

Mathematical Relations:

- To know the function $y = ax$ by extracting two quantities from a concrete phenomenon and to investigate their changes and correspondence.

- To expand student's ability to find, relate, and express relationships in terms of functions.

Two things should be noted about the requirements of mathematics for grades 7, 8, and 9. First, the level of the mathematics required in Japan is about two years higher than that found in the United States. Second, the contents of algebra, geometry, and probability are not found in three distinct classes as is the situation in the United States; rather, the three contents are interwoven across three classes.

Teacher Behavior in the Classroom

In general, the classroom teacher (*sensei*) is highly respected by the general populace and students. The students show their respect for their teachers at the start and end of class. At the start of class they stand, bow, and say, "good morning" or "good afternoon." When they leave, they also stand, bow, thank the teacher for the lesson, and say, "good-bye." Students also show respect to each other when they speak and stand when speaking.

Oral communication of mathematical ideas flows with ease between the students and teacher and among the students. For example, during a classroom observation, a student explained a solution that the teacher had not considered, and the teacher applauded the student's response and suggested that his classmates likewise applaud. On another occasion, as many as six students came before the class to demonstrate the supposed validity of their arguments. As they proceeded, the first five realized, as did their classmates, the fallacy of their arguments. The class spontaneously cheered the student who finally presented a valid argument.

In a classroom atmosphere where logical reasoning is stressed, students are willing to challenge the teacher's word, although whenever a student did so his or her classmates teased that student. The classroom atmosphere is very conducive to this kind of dialogue. The students also are able to communicate, orally and in writing, their mathematical thoughts in front of the entire class. The discussion of mathematics between and among students was not uncommon. The Japanese philosophy of teaching encourages much classroom discourse. This philosophy is implemented when students first enter elementary school.

Instruction in the middle school classroom is whole-class instruction that is student focused. This means the teacher orchestrates the activities in the classroom that are based on careful planning of lessons. These lessons are developed collaboratively among the mathematics teachers.

Two Teaching Strategies

Two teaching strategies are prevalent. These are commonly referred to as the "effective teaching strategy" and the "open-ended problems approach."

The Effective Teaching Strategy. This model of teaching is best described by Good, Grouws, and Ebmeier (1983) in their book, *Active Mathematics Teaching*. This model suggests that lesson development should take at least 50% of class time. Furthermore, it describes teaching behavior as follows:

1. Review briefly and/or identify prerequisite skills.

2. Focus on the development of meaning and comprehension, using active demonstration and teacher exploration.

3. Assess student comprehension (ask questions/work on supervised practice).

4. Repeat meaning portion of the lesson as necessary (using different examples and explanations if possible).

5. Provide practice opportunities for students:

(a) Practice should be short (one or two problems at a time).

(b) Students should be held responsible for assigned practice problems.

(c) Practice should be performed in a meaningful context (teacher provides frequent process explanations).

(d) When success rate is high, move students into seatwork portion of the lesson, where students have an opportunity for uninterrupted practice. (pp. 35-36)

Many of the lessons that I observed devoted more than 50% of class time to developing the lesson. Many times lesson development exceeded 75% of class time.

The Open-Ended Problems Approach. This approach calls for the teacher to present students with an initial problem situation that does not necessarily have predetermined answers or solutions. Then the teacher uses the students' various approaches to the problem in order to lead them to new knowledge by combining previous knowledge, skills, and mathematical ways of thinking.

The classroom activities are structured to help students discover mathematical rules or relationships. The teacher plans activities that make good use of students' knowledge and skills, help students solve problems on their own, and allow students to check their own answers. Students observe each other's discoveries, compare and examine the different ideas, and modify and further develop their own ideas accordingly.

The teacher orchestrates this approach by carefully selecting and posing a problem. Posing the selected problem may be enhanced by projecting the problem on a screen or by making use of such concrete materials as models that do not restrict the students' way of thinking about the problem. After the problem is posed, the teacher may be seen walking around and assisting students as they tackle the problem. The teacher tries to identify those students who do not understand the problem by reviewing the students' written record of responses, approaches, or solutions to the problem and then helps by giving more examples or suggestions to stimulate them to think in a relevant way about the problem. Students' activities at this stage are crucial to further development of the lesson. The teacher must be careful not to impose a particular orientation on all students by adopting the opinion of particular students. Instead, the teacher will lead the lesson from individual learning to a class discussion, and a new point of view, not yet having occurred to the students, will emerge.

Another means by which the teacher orchestrates the lesson is by summarizing what students have learned.

The teacher does this by writing the individual or group work of all students on the chalkboard even though some propositions may be similar to or duplicates of others and even if some are erroneous or incomplete expressions. These may be modified as students make comments about them. Thus, while appropriately incorporating and modifying students' responses, the teacher integrates and arranges them in order according to particular points of view.

Drill and Practice

Teachers monitor the practice of skill work in specially designed courses. Some of the classes may be just 10 minutes long and others may cover a complete period. In the latter classes, the teacher usually demonstrates the procedural skill. The students then work on their own, and their work is corrected in class by either the teacher or the students themselves using a key provided by the teacher. These period-long classes usually are offered during the ninth grade. By this year they have completed their study of algebra and geometry. It also is the year in which they take important high school entrance examinations.

Students who attend *juku* schools (private, after-school classes) for mathematics gain additional practice. Students usually attend these schools twice a week.

Teachers also assign practice work as part of the students' homework. The problems may come from a supplementary mathematics textbook that students must buy. Sometimes teachers make worksheets for the stu-

dents. These are called *printos*. Homework may be corrected by the students themselves or by the teachers. Generally, it is not corrected and not discussed in class.

Assessment

In the Japanese seventh- and eighth-grade classrooms, the focus of assessment is on how each student thinks according to his natural way of thinking, or ability. These ways of thinking mathematically, correct and incorrect, are regarded as concrete information about the students' progress in learning. In this approach, the teachers' observations of students during the lesson are an important source of assessment. Teachers make two kinds of observations: 1) observations of students' work on the problem while walking around the room, noting whether students' responses are as anticipated; and 2) observations made during discussions with students. After the lesson, students' worksheets are collected and analyzed as another crucial source of information to evaluate both the lesson and the individual student's performance.

The teacher also uses formal assessments, depending on paper-and-pencil tests. This is especially true for grade nine, when students are preparing to take exams for entry into high school.

Instructional Materials

Instructional materials in the middle schools consist of textbooks and supplementary materials. The plan of the mathematics curriculum at the school level is built

around the textbooks' organization and content. The textbooks' tables of contents are very detailed, which facilitates planning.

Japanese textbooks are small compared to American textbooks. They tend to be softcover books measuring 15 cm x 21 cm (5.9 inches x 8.2 inches) and containing about 175 pages. They contain the essential mathematical ideas and skills that the students are expected to learn.

Japanese textbooks contain few drill and practice problems. Students are asked to buy books written for drill work and supplementary books that are used as homework books. Textbooks are provided free to students in public and private schools in grades one through nine by the Ministry of Education, Science, and Culture. However, private school students generally buy their textbooks and any needed supplementary books.

The prefectural boards make their textbook selection based on how the schools vote. Teachers decide for which text their school will vote. They base their decision after reviewing texts at a textbook exhibition. Once selected, the same text is used for three years. Because prefectural boards decide on the textbooks to be used, numerous schools at a given grade level will be using the same text. For example, 32 middle schools of Nerima Ward in Tokyo used the same mathematics textbook at each grade level.

In the case of private schools, the principal adopts textbooks from the list authorized by the ministry. He receives information and advice from the prefecture.

Although textbooks are of paramount importance in Japanese middle schools, other materials are used to reach the objectives of the school program. For example, at one of the schools I observed, sufficient materials were lacking for reinforcing, maintaining, and applying the skills and concepts learned. Students were assigned additional work from supplementary workbooks. These workbooks consisted mainly of problems to be solved, following a sample problem and solution.

In addition to workbooks, students may use drill books. These books consist of only drill-type problems to develop algebraic computational skills. No explanations are given behind the calculations. Students may practice these drill-type problems in their "drill" classes, where all types of drill materials are practiced. In these classes students are usually self-directed.

Teachers also develop their own supplementary materials, *printos,* to assist their students. These paper handouts vary in content. They include glossaries, summaries of key concepts and generalizations, and problems for application. In addition, the teachers write their own quizzes and examinations. In order to do their best teaching, the teachers find it necessary to develop supplementary materials for their students.

Teacher Beliefs About Effective Teaching

In response to an instrument of 41 items (based on the Teacher General Classroom Process Questionnaire of the Second International Educational Association

Mathematics Study) that suggest what teachers might do to make their teaching more effective, 80% or greater of the teachers from 77 public schools and 23 private schools in Tokyo chose the following items as being of major importance or among the highest in importance. These behaviors may be considered under the broad categories of needs of the individual, lesson planning, and classroom management.

Needs of the Individual

- Make encouraging remarks to individual students as they work.
- Identify students who are in difficulty but do not ask for assistance.
- Try to develop warm, personal relationships with students (rated by 90% of the teachers).
- Write meaningful comments as well as grades on student work.

Lesson Planning

- Think about how to clear up instructional problems that arose in the course of a previous lesson.
- Review tests with students shortly after the tests have been graded.
- Provide an opportunity for students to discover concepts for themselves.
- Make presentations as lively as possible (rated by 94% of teachers).

Classroom Management

- Get materials, equipment, and space ready before class.

- Make sure that students know exactly what they should be doing at any given time.
- Plan transition from one activity to another.
- At the end of the period, summarize the materials that have been taught during the period.
- Allow the discussion to continue longer than planned when students show particular interest (Whitman and Lai 1990, pp. 71-81).

Teacher Behavior Outside the Classroom

Teacher behavior relative to the content that is taught in the classroom is determined in large measure by the *Courses of Study* issued by the Ministry of Education. Historically, changes to the *Courses of Study* have been made approximately every 10 years.

Teachers participate as part of a group in the curriculum formation process. There is extensive dialogue among the various interested groups and the ministry, and only when some kind of overall consensus is reached by all concerned is the basic curriculum written by the ministry.

This process has the advantage of resulting in a curriculum that all interested parties help shape and thereby are committed to implementing. On the other hand, this process is very time consuming; the 10-year cycle for curriculum revision provided by the government is not unreasonable. Compromises can be expected before consensus is reached. This may or may not be a disadvantage, depending on one's viewpoint. A definite advantage of this process is that the curriculum that

emerges conforms to an official standard and ensures that "children throughout the nation are exposed to a common body of knowledge" (Cummings 1980).

Planning Activities. Japanese teachers spend much effort in planning their school curriculum and their lessons. Although *Courses of Study* outlines the aims and content of each subject, individual schools organize, extend, and enrich the content. The teachers for each content area are involved in this process. At the start of the school year they meet to organize their curriculum for the entire school year. These curricula are organized into a monograph and published. In addition to being used by the teachers, the monograph is used by various committees, including the board of education that supervises the particular school. For example, at Kitamachi Middle School the mathematics curriculum included the months of instruction, the chapters and sections of the text, the number of days to be spent instructing each section, the items in each section, and a description of the content of each section.

In addition to annual plans, teachers develop lesson plans. They consider it important to develop and polish lesson plans in a collaborative manner, including listing the students' anticipated responses to the problems posed in a lesson. Teachers feel that in so doing they get a better understanding of the lesson and are better prepared to anticipate and deal with students' responses and viewpoints when actually teaching.

For collaborative planning by the teachers to take place, it is imperative that they have the necessary time

and circumstances for it to occur. This is possible in Japan because teachers in general teach four contact hours, which leaves time for planning. In addition, teachers in Japan share a large room, each with a desk, chair, and file. This gives teachers opportunities to interact when planning lessons and to discuss professional matters relating to their students, teaching, and the mathematics curriculum. This common teachers' room is organized so that the desks of a particular grade level of teachers are clustered close by, making meetings, discussions, and planning easy to manage.

In general, a teacher's lesson plan will include eight parts: 1) a simple objective, 2) a statement of the problem, 3) further introduction and development of the problem with the class, 4) a list of the students' anticipated responses, 5) a discussion of responses with the students (includes detailed questions to ask students), 6) generalizations of results (possible examples are written), 7) a summary of the lesson, and 8) homework assignments as necessary. In many ways the lesson plan for the Japanese teacher is like a script for the classroom. The teacher seeks to perfect the script.

Teachers interact with their students not only during formal class times but also outside of class: during breaks between classes, during recess and lunch hour, before and after school, during the students' club activities, and during homeroom activities.

The homeroom teacher has the responsibility of advising each student as to which examination the student should take to maximize his or her chances of success. This is important because a student must pass an

examination to enter a high school, and there is only one opportunity each year to take the exam. This advising and guidance process begins when the student enters middle school. The placement activities increase in the second year and become a driving force when students enter their third year. In this process the role of the homeroom teacher is an extension of the role of the parents. Not only do teachers try to get their students into the appropriate schools, but they also want their students to think about the kind of life they see for themselves in the future (LeTendre 1994).

Teachers also appear as extensions of the role of parents during the lunch hour. Teachers have lunch with their homeroom students in their homerooms. Here the students learn how to behave while dining. Students cluster their desks into groups of four to six to eat. Some students even bring tablecloths to give their dining experience a home-like appearance. The teacher rotates dining among the small groups.

Some teachers find it necessary to devote time to student club activities. This is a way of being involved with students more frequently. With more time spent with the students, administrators and teachers hope to reduce the incidence of violence or misbehavior. Unlike in the United States, club (extracurricular) activities are required in Japan, but students are allowed to choose the clubs they want to join.

In the Profession

Middle school teachers are required to have a relevant teaching certificate, which is awarded by the

prefectural board of education. These certificates are classified as regular, special, and temporary. The first two types are for regular teachers and are awarded for life, and the latter is for assistant teachers. The certificates are further classified according to content area. Middle school teachers teach the subject for which their teacher certificate has been awarded.

Teacher Training. Teacher training for regular teacher certificates is provided at universities and other institutions of higher education. In addition to basic qualifications, such as a bachelor's degree course of study, to obtain a teaching certificate students are required to acquire the prescribed number of credits for teaching and specialized subjects in courses approved by the ministry. For example, to obtain a regular first-class certificate the middle school teacher must complete the bachelor's course and acquire 20 credits for teaching subjects, 31 credits for specialized credits, and eight credits in teaching subjects or specialized subjects. Education students also are required to work for seven days as caregivers in special education schools or social welfare facilities to be awarded regular teacher certificates.

Inservice. Because the law requires teachers to pursue consistent inservice training, systematic programs are conducted at various levels. At the national level the Ministry of Education holds "central workshops" for the inservice training of principals, vice principals, and coordinating and advising teachers who play leading roles at the prefectural level. The ministry also sends

about 5,000 teachers abroad every year to broaden their international perspective and to gain an increased awareness about their chosen profession. The ministry gives grants for inservice training administered by prefectural boards of education, teacher training organizations, and others.

Prefectural boards of education are required by law to be responsible for planning and encouraging daily inservice training in local public schools. Prefectural education centers, which have lodging facilities, educational equipment and apparatus, and a professional staff, play an important role in inservice education.

Prefectural boards of education also send teachers to universities, research institutes, private firms, and other institutions for long-term training. They conduct periodic inservice training at different stages of a teacher's career, for example, after five years, 10 years, and 20 years of service. Another type of inservice training is directed toward meeting the learning needs of teachers in various positions, such as principals, vice principals, and coordinating and advising teachers.

In addition to these inservice programs, municipalities and education organizations hold lectures and workshops.

Induction. A system of induction training for one year after their initial appointment is required of beginning teachers. This training takes at least 90 days, spread out over the school year. Sixty or more of these days are school-based training, during which beginning teachers receive instruction from their advising teacher. Not

less than 30 of these days are spent attending lectures, seminars, and various practical training sessions that include five-day workshops held in education centers or other institutions outside of school. Prefectural boards of education and the boards of education in 12 designated cities plan concrete programs of induction training and provide substitute teachers during the training. To promote communication among teachers from different types of schools and from various geographic regions, the ministry conducts a nine-day induction-training cruise in conjunction with the prefectural board of education.

Research. Teachers tend to participate and engage in research designed to improve their classroom teaching. One teacher I observed had tape recorders placed at the students' tables so that he could listen to their conversation about the lesson after class.

A common form of research is called "lesson study." The intent of such study is to improve the lesson. These improved lessons are then shared with other teachers in the school and beyond. Because curricula are fixed throughout Japan, what is learned locally about teaching is of value to teachers in other localities.

When a lesson is tried, some of the teachers in the school observe the lesson. Together, the teachers analyze and evaluate the lesson. Based on this evaluation, the lesson is revised and then tried again. This new tryout generally involves more teachers and administrators — and outside experts. The discussion after the tryout goes beyond the lesson and involves general issues raised by

the ideas that guided the design of the research lesson. Sitting at one of these meetings, one has the sense that teachers are truly engaged as researchers.

The teacher's lesson study does not end with a successful presentation and oral critique. His or her work is widely shared through a book-length report. The book is read by the faculty and principal and perhaps sent to the education authorities at the prefectural level. If a university professor worked with the lesson-study group, the report might be written for a wider audience and published by a commercial publisher. Part or all of the research might be funded by a grant from the ministry or the prefectural board of education.

Of the five schools and 15 classes that I observed, it appeared that all of the head teachers and principals were knowledgeable and active in education research. There was much interest in the "open-ended" approach to teaching and in lesson plan research.

Textbooks. In addition to engaging in research, some of the teachers are involved in writing textbooks that may be among those approved by the ministry. Generally the classroom teacher is part of a team of writers. A university person invariably is also a member of the team. As a textbook writer, the classroom teacher is very much aware of the latest thoughts and guidelines for textbook writing. The guidelines (*Courses of Study*) delineate what is expected of texts on the list of approved government books.

Teachers also are involved in selecting texts that their school will use. Teachers from each school review

ministry-approved books at a textbook exhibition and advise the prefectural board about which books should be adopted.

In the Community

Many school activities engage teachers and the community, especially the parents of students. The first activity of the school year is the "opening day" ceremony. This is quite a gala, with parents and teachers all dressed up for the occasion. Dignitaries are invited to give the welcome speeches to the new group of students and to welcome back the returning students. Returning students also may stage a special presentation.

Another activity involving the community is the school assembly. An assembly may include speakers from the community or visitors from other provinces or from abroad.

Sports festivals also draw in the community. Groups of students compete for sports awards. The focus for the students is on getting the awards for their team, rather than for themselves individually.

Teachers also are involved with the community through home visits. Visiting the homes of their students is considered a standard responsibility of a classroom teacher.

When a student runs into difficulties outside of school, the authorities first notify his teacher, who in turn notifies the student's parents. In a way, the relationship between teacher and student seems somewhat similar to a parent and child relationship. The students

have nicknames for their teachers that appear as terms of endearment. The teachers' concern for their students is so high that teacher union strikes were conducted after school so that students would not be penalized as a result of the strike.

Equality and Equity

Providing each student an equal opportunity to learn is fair and democratic. When interpreted in the school context, it means providing each student with the same schooling. Therefore, most Japanese educators would consider the idea of tracking students undemocratic and unfair. Instead, to ensure that all students have an equal opportunity to learn, students are not grouped by achievement or ability when attending compulsory schooling (grades one through nine). In addition, parents have accepted the idea of government control of education to be sure that all students are treated equally.

This equality of treatment goes beyond having a common curriculum. It includes equal financial support and physical facilities. It also includes the uniform quality of the teachers and administrators. One way this is enforced is by having national standards for teacher certification and the rotation of school personnel so that the unpopular regions are not left with the least desired teachers and administrators. For example, after an absence of 15 years, none of the teachers or administrators I earlier worked with at the Kitamachi Middle School

were still there. As another example, in Kanagawa Prefecture (south of Tokyo), the novice teacher (those assigned to a school for their first career) can stay at that school for as long as six years, whereas the non-novices can stay a maximum of 12 years. Usually, after teaching at the same school for three years, a teacher can file a request to move to another school.

There is much discussion about the Japanese education system cultivating creativity, and provisions for it were made in the 1989 revision of *Courses of Study*. But in some areas this reform is slow or nonexistent. For example, Kitamachi Middle School still had no classes for gifted and talented students nine years later, in 1998.

Equity is a factor in middle school students going on to further education. Although post-middle school education is not required, nearly all students continue their education. To get into the high school of their choice, students must pass the school's admission test. It is critical that students take the examination of a school for which they are certain to pass. If they do not pass and still want to enter a particular school, then they must wait another year before trying again. The homeroom teachers at the middle school have the responsibility of advising their students about which examination to take.

Comparing the Japanese entrance-examination system to our achievement-exit system, we see in Japan no focus on provincial examinations. There is no comparing of various schools' achievement. Instead, comparison is based on the success of a school in placing students in prestigious high schools. We also see no standardized

testing in Japan; however, the Ministry of Education and the National Institute of Education do test a sample (less than 10%) of the student population to estimate the effect of the curriculum guidelines on student achievement.

Conclusion

We in North America cannot adopt unaltered the ways of the Japanese because of the great differences between our cultures. What follows, therefore, is a discussion of ways that our education system might consider some of the most positive aspects of Japanese mathematics education for adoption or adaptation. Many other aspects of Japanese education also are relevant for consideration, but I have chosen to focus on mathematics at the middle school level.

Teaching Techniques. Japanese teachers use whole-class instruction. This technique, whereby the teacher teaches to the whole class but with the focus on individual participation, could be added to our repertoire of techniques. Whole-class instruction does not mean teacher-dominated or lecture-oriented instruction. Rather, it means teacher-orchestrated instruction. The teacher begins the lesson by posing a problem for solution. The students work individually or in groups to solve the problem while the teacher walks around and works with the students. Eventually, the teacher elicits the ideas and solutions from individual students. The students' suggestions are the source of ideas. Right or

wrong suggestions are all recorded on the chalkboard for all to view and study. The discussion of the students' ideas is extensive. Based on the students' input, the class reaches consensus. Finally, the teacher summarizes the lesson and makes conclusions.

One advantage of whole-class instruction is that the teacher is teaching everyone at the same time, thereby allowing more teacher and student interaction time. Another advantage is that it encourages the notion of multiple ideas in solving problems.

Teacher Education and Development. The techniques used in Japan to develop effective teachers, from teacher education to inservice training, need careful consideration. It is imperative for a mathematics teacher to have a solid background in mathematics. Evidence of this knowledge needs to be demonstrated through examinations. Teachers need to be able to prove their ability in the area they teach.

As teachers begin to teach, they also need the guidance of a more experienced teacher — a mentor. Opportunities should be provided so that new teachers can observe outstanding teaching and have opportunities to discuss teaching with the experienced teacher.

Teachers need a lighter teaching load. With lighter teaching loads, teachers will have more opportunities to collaborate on such matters as planning and evaluating lessons, observing other teachers, and participating in research geared to improving instruction.

Teachers also continue to develop through inservice education. Teacher-led inservice education for the entire

school, with a focus on lesson development, is important to bring about school reform and reform in the classroom.

Curriculum. The mathematics curriculum should be integrated, rather than separated into yearlong courses for algebra and geometry and semester courses for probability and statistics. The integrated content of these courses should begin to be taught in the middle school. Mathematics should be taught in depth instead of touched on lightly and repeatedly. The focus of the curriculum should be on solving problems and learning concepts. Drill time is important and should not be overlooked but might be structured differently, such as in sessions of various lengths.

Heterogeneous grouping and inservice training for teachers about how to instruct heterogeneous groups could be valuable. The successful instruction of heterogeneous classes in algebra and geometry already has occurred in some middle schools in the United States.

Scheduling and Facilities. Schools should provide for 45 to 50 minutes per class. Longer classes are not recommended for mathematics. The number of mathematical concepts and skills that students may learn in a fixed interval is limited. Students need time to reflect on and apply the mathematical concepts they have learned. Also, incorporating breaks of 10 to 15 minutes between classes could provide students with time to "clear their minds" or to "change their bearings" before proceeding to the next class. These breaks also give students opportunities to be physically active throughout the day.

Teachers of all subjects need a place where they can meet and work collaboratively. Such a room should be inviting to the teachers and not overrun by social activities. The room should be a planning and work center.

National Focus. Finally, we need to agree on academic standards. In the United States mathematics standards were developed by the National Council of Teachers of Mathematics with input from professionals and lay persons. National standards help to ensure that every student has the opportunity for equal and fair education.

We also need to continue developing national assessments to obtain information about the academic achievement of students. Such data will serve not only to inform the country but also to suggest where and how to improve schools.

By following the lead of what works in Japan, educators in our hemisphere can improve mathematics education in the middle grades.

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